The harvest of wild birds for aviculture: an historical perspective on finch trapping in the Kimberley with special emphasis on the Gouldian Finch

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ABSTRACT

Commercial trapping of finches by licensed trappers was permitted in the Kimberley region of Western Australia until the end of 1986. We provide a history of the trade, focussing particularly on the period since 1968. Details are provided of the legal and policy framework in which the trade operated, trappers, capture, handling and marketing methods, and capture tallies. Reasonably accurate capture tallies are available from 1974. From then until 1986, over 280 000 finches of eleven species were caught and sold. The number of trappers declined by 50% during that time, but the number of finches caught did not decline. However, the number of Gouldian Finches captured declined sharply after 1977. Regression analyses of Gouldian Finch capture rates failed to identify any consistent rainfall or market variables which might have contributed to the decline. We conclude that the data are consistent with the hypothesis that the Gouldian Finch suffered a major population decline in the Kimberley area in the late 1970s. We also discuss a range of "sustainable conservation" issues related to the harvest of wild birds for the avicultural trade and suggest that a "sustainable conservation" strategy aimed at establishing a viable captive population is incompatible with a strategy aimed at protecting habitat.

INTRODUCTION

Tropical woodlands are the major centre of diversity of finches (Class Aves, Family Passeridae) in Australia. Of Australia's 18 native passerids, 14 are present in the tropical woodlands and six are endemic to them (Table 1). Eleven species, including all six tropical-woodland endemics, are present in the Kimberley region of Western Australia (Table 1).

The abundance and diversity of finches in the Kimberley region supported a small industry supplying birds for the avicultural trade from at least the 1940s (Sharland 1949) until the complete prohibition of finch trapping in Western Australia at the end of 1986. Its importance as a source of tropical native finches was elevated by the complete ban on the trapping of wild native finches in Queensland in 1972. Commercial finch trapping was probably also phased out in the Northern Territory during the 1970s.

Amongst the eleven species of finch that occur in the Kimberley area (Blakers *et al.* 1984), one of the most sought after and frequently captured was the Gouldian Finch *Erythrura gouldiae* (Anon. 1987) until it received total protection at the end of 1981. The species is one of a number of granivorous birds of the Australian tropical savannahs that are thought to have declined (Garnett 1993; Woinarski 1993). Its current official ranking as Endangered (Garnett 1993; Australian Nature Conservation Agency 1994; Collar *et al.* 1994) has been supported by recent surveys demonstrating a widespread but sparse and patchy distribution (Blakers *et al.* 1984; Evans and Bougher 1987; Tidemann 1987; 1996; Dostine, unpubl. data), brief and therefore unavoidably selective reviews of anecdotal evidence that suggests it was once more abundant and widespread (e.g., Blakers *et al.* 1984; Garnett 1993), and a decline in capture rates reported by commercial trappers operating in the Kimberley region.

Based on data provided by the Department of Conservation and Land Management in Western Australia (CALM), Evans and Fidler (1986) and Tidemann (1987) showed that the number of Gouldian Finches caught by licensed finch trappers in the Kimberley region of Western Australia declined from *c.* 6 500 in 1972 and 1973 to 4 573 in 1977 and to 1 054 in 1981. This decline was without parallel amongst the other species trapped. However, the same data set used to "demonstrate" that the Gouldian Finch

Table 1. Species of Australian native finches (family Passeridae) and their occurrence within the tropical woodlands. Nomenclature follows Christidis and Boles (1994). Occurrence follows Blakers *et al.* (1984). TW = occurs in the tropical woodlands, * = endemic to the tropical woodlands, (K) = occurs in the Kimberley region.

Common name	Scientific name	Occurrence
Zebra Finch	*Taeniopygia guttata*	TW (K)
Double-barred Finch	*T. bichenovii*	TW (K)
Long-tailed Finch	*Poephila acuticauda*	TW* (K)
Black-throated Finch	*P. cincta*	TW
Masked Finch	*P. personata*	TW* (K)
Crimson Finch	*Neochmia phaeton*	TW* (K)
Star Finch	*N. ruficauda*	TW (K)
Plum-headed Finch	*N. modesta*	TW
Red-browed Finch	*N. temporalis*	TW
Diamond Firetail	*Stagonopleura guttata*	
Beautiful Firetail	*S. bella*	
Red-eared Firetail	*S. oculata*	
Painted Finch	*Emblema pictum*	TW (K)
Yellow-rumped Mannikin	*Lonchura flaviprymna*	TW* (K)
Chestnut-breasted Mannikin	*L. castaneothorax*	TW (K)
Pictorella Mannikin	*Heteromunia pectoralis*	TW* (K)
Blue-faced Parrot-Finch	*Erythrura trichroa*	
Gouldian Finch	*E. gouldiae*	TW* (K)

declined also shows a sharp increase in the numbers captured from 1 305 (or 1 035) in 1970 to the 1972/73 high. Evans and Fidler (1986) partly explained this increase by demonstrating that the increase in the number caught *per trapper* from 1968 to 1972 was much less than the subsequent decline.

Yet another perspective on the CALM data was suggested by I. Mitchell (pers. comm.). Mitchell suggested that the total capture rate of Gouldian Finches increased with increasing rainfall in the previous March and April to a point and then declined with a further increase in rainfall, and that the decline in capture rates in the late 1970s and early 1980s was therefore best understood as a population fluctuating in response to natural climatic variability.

Apart from a few anecdotal accounts of trapping (Sharland 1949; Tidemann 1993; see also Perez 1955 for an anecdotal account of trapping in the Northern Territory), there appears to be no published historical material about the Kimberley-based finch trade. Such material is of interest for the light it has or may shed on the status of the Gouldian Finch. It also has the potential to offer interesting perspectives on the harvest of wild birds for aviculture. This is a topic of particular note given current interest in sustainable utilization for conservation in Western Australia (Shea *et al.* 1997), the Northern Territory (Parks and Wildlife Commission of the Northern Territory undated), and internationally (e.g., McNeely *et al.* 1990; Freese 1996) and in the harvest of wild birds for aviculture in particular (Thomsen and Brautigam 1991; Moyle 1997; Parks and Wildlife Commission of the Northern Territory 1997).

In this paper, we provide a brief history of the industry based primarily on Department of Conservation and Land Management files. We concentrate mainly on the period from 1968 to 1986, both because it is for this period that most data and information are available, and because this period is most relevant to the putative decline of the Gouldian Finch. We consider a range of historical factors, including the legal and market framework in which the trade operated, and the trappers themselves, which may have influenced the capture rate of finches. We also review the quality of available data on capture rates and provide additional, previously-unpublished data. Numerical analyses of Gouldian Finch capture rates are undertaken in order to consider alternative hypotheses to explain the decline in capture rates. Results are discussed in the context of "sustainable conservation" strategies and the status of the Gouldian Finch.

METHODS

History

Historical information was for the most part gathered from unpublished documents held on the files of the Department of Conservation and Land Management. These included tallies of finches taken, annual reports of the Wyndham-based Wildlife Officer, minutes of the Bird Committee of the National Parks and Nature Conservation Authority (earlier, of the Western Australian Wildlife Authority), reports prepared by or for the Chief Wildlife Officer and a 1977 submission by R. Birch on behalf of the licensed trappers. Other sources include personal communications with former bird

dealer Ray Ackroyd and perusal of purchase documents held by him.

Very little information is available for the period prior to 1968. Except where specifically stated otherwise, our comments refer only to the period 1968 to 1986 inclusive.

Numerical analyses

There are two useable data sets — the capture rates of a single trapper, J. Long, from 1948 to 1972 (hereafter referred to as the *jlong* analyses), and capture rates for a number of trappers (all trappers from 1974) for 1968 to 1981 (hereafter referred to as the *alltrappers* analyses).

Analyses have been conducted using capture rates per trapper and proportional capture rates, measures considered preferable to total capture rates because they provide varying degrees of control over the impact of variation in the numbers and effort of the trappers on the data. Proportional capture rates are the number of finches of a given species captured divided by the total number of finches captured. Per trapper capture rates have been square-root transformed, and proportional capture rates arcsine-transformed prior to analysis. Where relevant, all statistical tests are two-tailed. Gouldian Finch capture rates have been analysed by multiple regression performed by the step-down procedures recommended by Zar (1984) with a critical $\propto$ of 0.05.

For multiple regression analyses, independent variables for which there are data available fall into two broad categories — those related to the "human factor" such as price, legal restrictions and the number of trappers, and weather variables. Both the length of the trapping season and the number of trappers declined over time, at least since 1973 (this study). They have therefore been fused into a single variable "year". However, both year and price are potentially either causal variables or results of the capture rates. For example, a negative correlation between year and capture rates could simply reflect a decline in the availability of the species, and variation in price could have driven trappers priorities (demand) or be a response to finch availability (supply). To deal with this nexus, we conducted regression analyses both with and without these "human factor" variables, and with these "human factor" variables separately.

We have been able to obtain prices paid to trappers for Gouldian and other finches for only four years between 1968 and 1981. However, we do have access to prices recommended by the Avicultural Society of Australia for the period 1968 to 1981 for all finch species found in the Kimberley. To eliminate inflationary effects and its correlation with "year", "price" is a measure of relative value calculated as follows. The value of all species except three rarely caught species (Zebra Finch, Painted Finch and Yellow-rumped Mannikin) was summed, and the value of the Gouldian Finch calculated as a proportion of this index. The Gouldian Finch has three naturally-occurring head-colour morphs and prices for them differ. We therefore calculated the Gouldian Finch price as a weighted average of these, in the ratio of three black-headed birds to one red-headed and ignoring the very rare yellow-headed form, reflecting their ratio in the wild (Immelmann 1982).

An additional categorical variable "period" was included in the *jlong* analyses, indicating whether the year was before or after the beginning of 1960 when the overseas export of native finches was prohibited. This variable was included in the second stage of analyses, i.e., with rainfall variables, as there is no reason to see it as a potential dependent variable.

Eight rainfall variables were included in analyses (Table 2). These variables were selected on the basis of their reported relevance to trapper success (this study), postulated relevance to Gouldian Finch biology (S. Garnett, pers. comm. and the authors' unpubl. data) and the hypotheses proposed by I. Mitchell (unpubl.). The latter comprise

Table 2. Rainfall variables included in multiple regression analyses of Gouldian Finch capture rates.

Variable	How calculated
Onset Previous Wet	rainfall during previous Trapping Season (see below)
Rainfall Previous Wet	total, October to April prior
Rainfall Late Wet	total, March to April prior
Rainfall Late Wet Squared	total, March to April prior squared
Rainfall During Dry	total, May prior to September
Rainfall During Trapping Season	total, July to November
Rainfall During Trapping Season Squared	total, July to November squared
Variability in Onset of Wet	see text

Rainfall Late Wet and Rainfall Late Wet Squared, offering the potential for the quadratic relationship Mitchell proposed. With the exception of Variability in Onset of Wet, rainfall totals used are those for the Kimberley Research Station at Kununurra (15°39'S, 128°42'E), which is central to the area where most Gouldian Finches were trapped. An index of Variability of Onset of Wet index was calculated using monthly rainfall totals from four stations in the Ord River valley, the Kimberley Research Station, Argyle Downs (16°30'S, 128°55'E), Lissadell (16°41'S, 128°33'E) and Spring Creek (16°49'S, 128°52'E). For each weather station, we scored the first month after August in which 20 mm or more rain fell (September = 1, October = 2, November = 3, December = 4). For each year, we summed the scores of the four stations and subtracted 4 × the lowest individual score, providing a whole-number index that ranged from 0 to 5.

HISTORY

Law, policy and administration

From 1912 until their complete protection at the end of 1986, the capture of wild finches in Western Australia for sale was subject to a licence issued by the relevant conservation agency of the Western Australian Government. The circumstances under which such licences were issued, and the regulations and conditions applicable to them, became progressively more restrictive, particularly from 1952 (Table 3), when trapping was limited to the Kimberley Division. Prior to 1952, non-commercial trapping of finches was unregulated. From 1952 until 1986, property owners could destroy, but not sell, pest finches without a permit.

Table 3. Historical changes to key legislative and regulatory controls over commercial finch trapping in Western Australia

Year	Change
1912	commercial trappers required to be licensed
1952	— finch trapping restricted to the Kimberley Division — trapping limited to a declared season — trapping restricted to licensed commercial operators and property owners
1960	the Commonwealth Government prohibits the commercial export of all native wildlife
1973	trappers required to provide records of the numbers and species of birds sold, and details of persons to whom birds were sold
1976	trapping of the Yellow-rumped Mannikin prohibited
1981	trapping of the Zebra Finch prohibited
1982	trapping of the Gouldian Finch prohibited
1986	quotas introduced — each trapper restricted to a total catch equal to personal average annual catch for 1980 to 1984 inclusive
1987	all commercial trapping of finches prohibited

The licence requirement was established under the *Game Act 1912* and maintained in its successors, the *Fauna Protection Act 1950*, the *Fauna Conservation Act 1950–1970* and the *Wildlife Conservation Act 1950*. The administering department was the Department of Fisheries, which in the 1960s became known as the Department of Fisheries and Fauna and later as the Department of Fisheries and Wildlife; in 1985 this function was included in the new Department of Conservation and Land Management.

It was departmental policy from at least the early 1970s to restrict and gradually phase out trapping by shortening the season and reducing the number of licences. From 1968 to 1973 inclusive, the legal trapping season closed on December 31. For the 1974 season the closure date was brought forward to November 30, and for 1975 to 1986 it was set at November 15. The commencement date was September 1 in all years from 1969 to 1986 inclusive except 1978, when it was September 8. Licences were granted only to residents of Western Australia, existing licences were not replaced upon the death or retirement of the licensee, and in several cases were not renewed because the trapper's performance was considered to be particularly poor (i.e., few finches were caught). The last new licence to be issued was in 1977, to an assistant upon the death of his licensee. In an attempt to avoid training potential new licence applicants, the use of assistants was banned for a brief period (*c.* 1976), the restriction being softened, following protests by the trappers, to a requirement that assistants could only be used if their names were specified on the licence.

Trapping licences were renewed annually and were subject to an annual fee which was $4 (or its non-decimal equivalent) during the 1950s and 1960s, being raised to $10 in 1971, $50 in 1977 and $65 in 1982. Trappers (and dealers) sending finches interstate required an export licence for individual batches of birds, and were required to pay a royalty on all exported birds. From at least 1974 until 1981 the royalty was $0.20 per bird with a minimum fee of $5. It was raised to $0.25 per bird with no minimum fee in October 1981.

The Department maintained an office in Wyndham from 1967, and on-ground supervision of licence provisions and enforcement of wildlife regulations was primarily the responsibility of the Wildlife Officer (previously,

the Warden) based there. Direct supervision of trappers in the form of visits in both the field and at home (where finches were held prior to sale) was fairly intense from at least 1976. From at least 1974, the Wildlife Officer submitted an annual report which provided species and trapper tallies. These reports frequently also included a summary of the activities, methods and "performance" of individual trappers, along with recommendations concerning licence renewal and associated regulations.

The Bird Committee, which included persons with expertise in ornithology drawn from both within and outside the Department, reviewed finch trapping returns and made recommendations to the relevant authorities. It was on their recommendation that the Yellow-rumped Mannikin and Gouldian Finch were removed from the open season notice in 1976 and 1982 respectively, prohibiting the legal capture and sale of the species. The Bird Committee recommended as early as 1975 that commercial finch trapping be phased out, although the decision to end finch trapping after the 1986 season was made independently by the Minister.

The finch trappers

The number of licensed trappers prior to 1974 is not known. Fifteen individuals were licensed to trap finches in the Kimberley Division at some time between 1974 to 1986. The number operating in any one year declined through attrition from 14 in 1973 to six in 1986 (Fig. 1). For a variety of reasons including illness and absence on business or for pleasure, not all licensed trappers trapped every year. Because of the short duration of the trapping season, many trappers had other employment and operated at weekends or during their annual leave; a few were retired or had flexible commitments, and trapped full-time during the season. Trapper J. Long was a Perth-based bird dealer who also purchased finches from other trappers. Prior to 1977, the use of assistants was evidently frequent, sometimes providing expert local knowledge.

Ten of the fifteen trappers were resident in or within 50 km of Wyndham; four lived in or near Perth and one in Kalgoorlie, travelling north for all or part of the trapping season. At least some of the assistants were drawn from local Aboriginal communities, and at least three of the licensed trappers were Aboriginal. At least one trapper in the 1940s operated out of the Derby area (Sharland 1949).

Trapping, handling and marketing

Finches were trapped either at waterholes or prepared seedbeds, mostly using spring-loaded or pull nets that were fired over

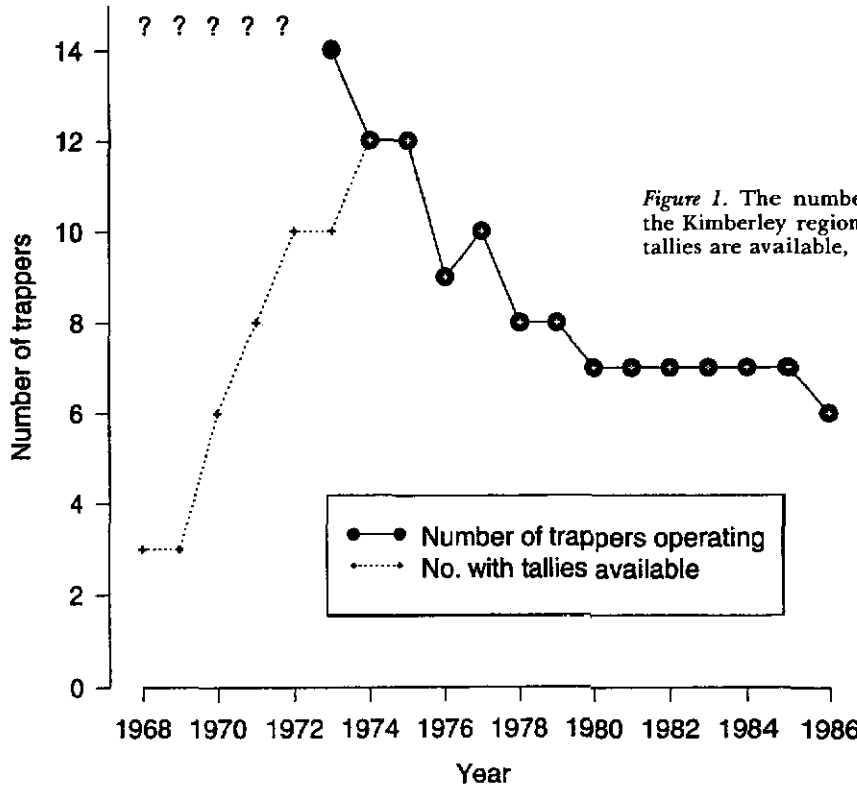

Figure 1. The number of licensed trappers operating in the Kimberley region, and the number for whom capture tallies are available, 1968 to 1986.

the birds. Waterholes were often modified to suit trapping, for example by grassing the edge, or covering the main waterhole and establishing a small alternative water source. However, a wider range of techniques was employed during the 1940s, including one-way cage traps baited with seed, water and "call birds", and bird lime (Sharland 1949). The use of "call birds" — caged birds whose call attracted wild birds and helped break down their caution — was subsequently banned, as presumably was the use of bird lime. Sharland (1949) and Tidemann (1993) provide original descriptions of techniques employed by commercial trappers.

The trapping season commenced late in the tropical Dry season when water was relatively scarce, continuing into the early Wet until legal closure or curtailment by the onset of widespread rain. Star Finches were mostly trapped early in the season, and trappers who did not travel to Camballin on the Fitzroy River caught few if any of that species. Most other species were trapped throughout the season as opportunities presented, possibly with greater emphasis on Long-tailed and Masked Finches early in the season and Gouldian Finches and Pictorella Mannikins later in the season. Rain curtailed the capture of most species by promoting dispersal or providing ready alternative watering points for the finches. However, it was reported that patchy early storms facilitated the capture of Gouldian Finches, apparently by promoting movements into areas where the trappers operated.

Identifiable trapping localities mentioned in Departmental documents (mainly Wildlife Officers' reports) show considerable concentration in and near the Ord River valley (Fig. 2). The map understates this concentration because of oft-repeated use of sites near to the homes of the trappers, probably because the Wildlife Officers were more likely to name far-flung and unusual localities and probably also because localities closer to the Wildlife Officer and trappers homes were more likely to be labelled with untraceable local names than were more distant localities. Favoured areas within this core were the King River, a variety of locations along the Great Northern Highway as far south as Turkey Creek and especially in the vicinity of the Dunham River, the Kununurra Irrigation Area, Oombulgurri Aboriginal Reserve and stations north of Kununurra-Carlton Hill, Ningbing and Ivanhoe.

Beyond the East Kimberley, the only regularly worked site was the Camballin area, 100 km south-east of Derby (Fig. 2). It was visited in most if not all years and by a number of trappers, mostly early in the season, with

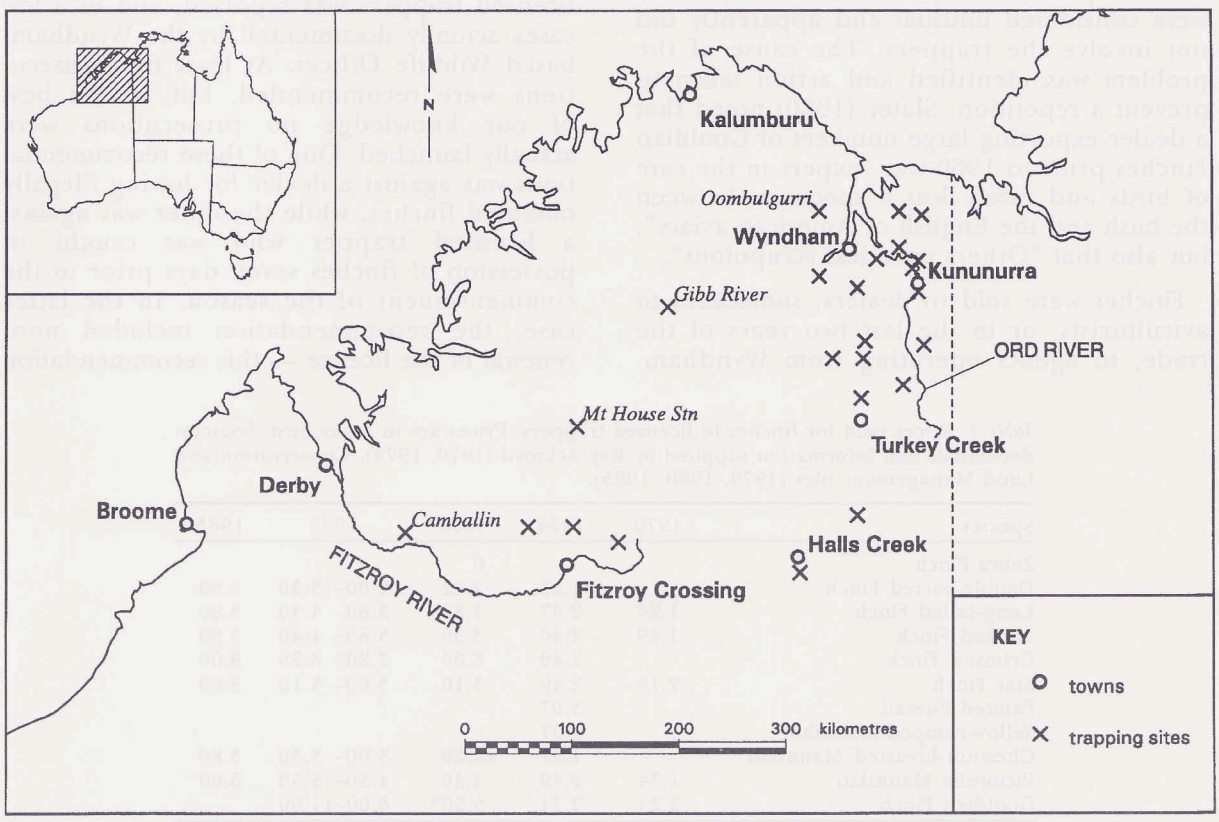

Figure 2. Location of finch trapping sites named in Departmental files, 1974 to 1986.

Star Finches being the prime target. Several trappers occasionally worked at a variety of locations along the length of the Gibb River Road, as well as at several sites north-west and north-east of Fitzroy Crossing. The Halls Creek area was worked infrequently, and one trapper travelled as far south as Balgo in the Great Sandy Desert on one occasion, although there is no evidence that he trapped there. Historically, other areas may have been utilized more frequently, and Sharland (1949) describes a trapper based near Derby "on one of his expeditions up the Fitzroy".

Following capture, birds were kept in boxes and transported by the trappers, usually to Wyndham. The construction of these boxes, including perches, was specified by regulation, as was the minimum space per bird. Wildlife Officers generally reported good standards of animal husbandry and few mortalities, but also reported a few notable exceptions. Amongst the exceptions was a trapper with a documented mortality rate of 10%, although it is not stated why or at what stage of capture or handling this occurred.

From Wyndham, the birds were variously flown, trucked or shipped elsewhere, and their survival during this stage is mostly beyond the ambit of the sources available to us. However, in 1977 a sequence of mortality episodes immediately prior to or during air transport was reported. These episodes were considered unusual and apparently did not involve the trappers. The cause of the problem was identified and action taken to prevent a repetition. Slater (1980) noted that a dealer exporting large numbers of Gouldian Finches prior to 1960 was "expert in the care of birds and rarely lost a specimen between the bush and the English or American aviary", but also that "Others were less scrupulous".

Finches were sold to dealers, sometimes to aviculturists, or in the last two years of the trade, to agents operating from Wyndham. They were shipped, flown or transported by road, mostly from Wyndham to Perth, but were also "exported" directly interstate. One trapper kept his finches until he had a truckload and took them to Perth and Sydney himself. Departmental records show that between 14 and 48% of the catch was sent interstate by the trappers (Table 4). However, we have few data, and some additional documentation demonstrates that interstate dealers frequently bought from Perth-based dealers rather than the trappers. Prior to 1960, far more finches were sent overseas than were retained for domestic sale (Ray Ackroyd, pers. comm.). The little information we have been able to obtain about prices paid to trappers is summarized in Table 5.

Table 4. The proportion of finches sold that were sent interstate directly by the trappers, and the estimated amount of revenue raised by the government from licence fees and royalties on these sales. Data are available for a limited number of years only.

Year	No. of finches sent interstate	Percentage of total finch catch sent interstate	Revenue raised ($)
1974	3 102	14.0	740
1979	5 166	30.7	1,433
1981	11 249	48.0	*c.* 2,900
1983	7 588	35.8	2,352
1984	10 942	42.2	3,190

Illegal trapping by both unlicensed and licensed trappers was reported, and in a few cases actually documented by the Wyndham-based Wildlife Officer. At least two prosecutions were recommended, but to the best of our knowledge no prosecutions were actually launched. One of these recommendations was against a dealer for having illegally obtained finches, while the other was against a licensed trapper who was caught in possession of finches seven days prior to the commencement of the season. In the latter case, the recommendation included non-renewal of the licence — this recommendation

Table 5. Prices paid for finches to licensed trappers. Prices are in $ per bird. Sources: documents and information supplied by Ray Ackroyd (1970, 1974), Conservation and Land Management files (1979, 1980, 1985).

Species	1970	1974	1979	1980	1985
Zebra Finch			0		
Double-barred Finch		1.57	2.42	3.00– 3.30	3.90
Long-tailed Finch	1.24	2.07	3.30	3.60– 4.40	3.80
Masked Finch	1.49	2.40	3.50	3.80– 4.40	3.90
Crimson Finch		2.49	6.60	7.20– 8.25	9.00
Star Finch	2.15	2.49	3.10	3.00– 3.10	3.60
Painted Firetail		3.07			
Yellow-rumped Mannikin		3.07			
Chestnut-breasted Mannikin		1.07	?2.20	3.00– 3.30	3.80
Pictorella Mannikin	1.74	2.49	4.40	4.50– 5.50	5.00
Gouldian Finch	2.24	2.74	5.50*	6.00–11.00	

* increasing to $8.00 per bird as the season progressed.

was also not acted upon. Another trapper received a warning from the Wildlife Officer for the illegal use of a "call" bird. It was considered by the Wildlife Officer that illegal activity by unlicensed trappers was more extensive and worrisome than that by the licensed trappers, and many of the licensed trappers were considered to be completely law-abiding.

Persons connected with the trade have informed us that it was not unusual for Gouldian Finches marketed as taken from the Kimberley to have been captured in the Katherine district of the Northern Territory, because the species was both common in the latter area and more readily trapped, being concentrated at the fewer available waterholes. Reportedly, trappers often moved to the Katherine area if heavy rains made it difficult to trap Gouldian Finches in the Kimberley.

Reports of the increased availability of finches in the markets in the eastern states prior to the opening of the Western Australian season caused concern to both the Wildlife Officer and apparently also to some of the trappers.

Finch capture rates

Although the formal requirement for trappers to provide sales totals for each species began in 1973, some data are available for earlier time periods. Capture rates are available for trapper J. Long for most years from 1948 until his death prior to the 1978 season. There are scattered records for a few other trappers prior to 1968, then a steady increase in the availability of data until congruence between the number of trappers operating and the number of trappers for whom data are available was achieved in 1974 and subsequently maintained (Fig. 1). However, there are numerous discrepancies in the record prior to 1978, some of them quite considerable. We have been able to resolve only some of these discrepancies, and in a few cases have had to resort to "best guesses". There is also ambiguity in some cases as to whether tallies are numbers sold or numbers caught, though most totals are the former and in some cases we have been able to distinguish the two. Our best resolution of capture tallies is presented in Table 6.

For the period 1971 to 1986, an average of 21 500 finches per year were captured in the Kimberley and sold (Fig. 3). The number caught varied between 13 500 and 24 500 per year from 1971 to 1983, increasing rapidly to a peak of almost 33 800 in 1985. Concern at this increase prompted introduction of a quota system, which limited the 1986 catch.

All eleven finch species recorded for the region were captured (Table 6). The most frequently captured species was the Long-tailed Finch (average 6 078 per year). During the period when its capture was permitted,

Table 6. Numbers of finches reported sold by licensed trappers, 1968–1986. Note that tallies for 1968 to 1973 are incomplete (see text). 1968 and 1969 tallies are those previously provided by CALM — we have been unable to trace the source of these records.

Year	Zebra Finch	Double-barred Finch	Long-tailed Finch	Masked Finch	Crimson Finch	Star Finch	Painted Finch	Yellow-rumped Mannikin	Chestnut-breasted Mannikin	Pictorella Mannikin	Gouldian Finch	TOTAL
1968	100	268	3 247	846	44	1 177	0	2	56	1 054	2 078	8 872
1969	3	411	3 056	682	91	1 300	29	9	160	772	1 671	8 184
1970	10	298	3 186	590	63	1 345	0	0	0	639	1 905	7 887
1971	100	338	7 017	1 901	822	4 362	33	41	66	2 590	3 707	20 977
1972	0	866	7 003	2 646	551	2 223	1	0	16	1 983	9 023	24 312
1973	0	845	3 685	1 442	248	1 730	0	23	304	760	7 189	16 226
1974	12	1 824	4 588	1 664	228	4 815	0	8	458	4 015	4 579	22 191
1975	0	1 030	3 616	1 015	299	5 021	1	109	1 059	791	4 191	18 632*
1976	0	1 117	5 831	2 358	186	4 753	0	**	788	975	3 775	19 783
1977	0	1 546	8 001	2 542	392	3 506	32	**	3 191	747	4 265	24 222
1978	0	1 425	4 850	1 787	707	1 524	0	**	777	632	1 888	13 590
1979	0	1 316	5 210	2 306	579	4 000	0	**	559	1 723	1 139	16 832
1980	0	2 279	6 757	2 792	1 117	3 579	7	**	1 461	1 956	1 128	21 076
1981	**	2 786	8 543	2 409	1 735	4 107	0	**	1 179	1 637	1 054	23 450
1982	**	3 158	4 916	2 812	2 250	4 082	12	20#	4 243	1 721	**	23 214
1983	**	2 528	3 930	1 756	2 046	5 756	27	**	2 297	2 821	22#	21 183
1984	**	3 054	6 336	3 118	1 549	5 221	0	**	4 763	1 868	**	25 909
1985	**	2 335	11 568	5 367	1 246	4 677	0	**	4 529	4 069	**	33 791
1986	**	1 907	5 407	3 004	1 115	982	2	**	1 712	4 577	**	18 706
1974–1986	12	26 305	79 553	32 930	13 449	52 023	81	137	27 016	27 532	22 041	282 567

* includes 1 500 finches trapped but for which species details were not provided
** trapping not permitted
# trapped under special permit

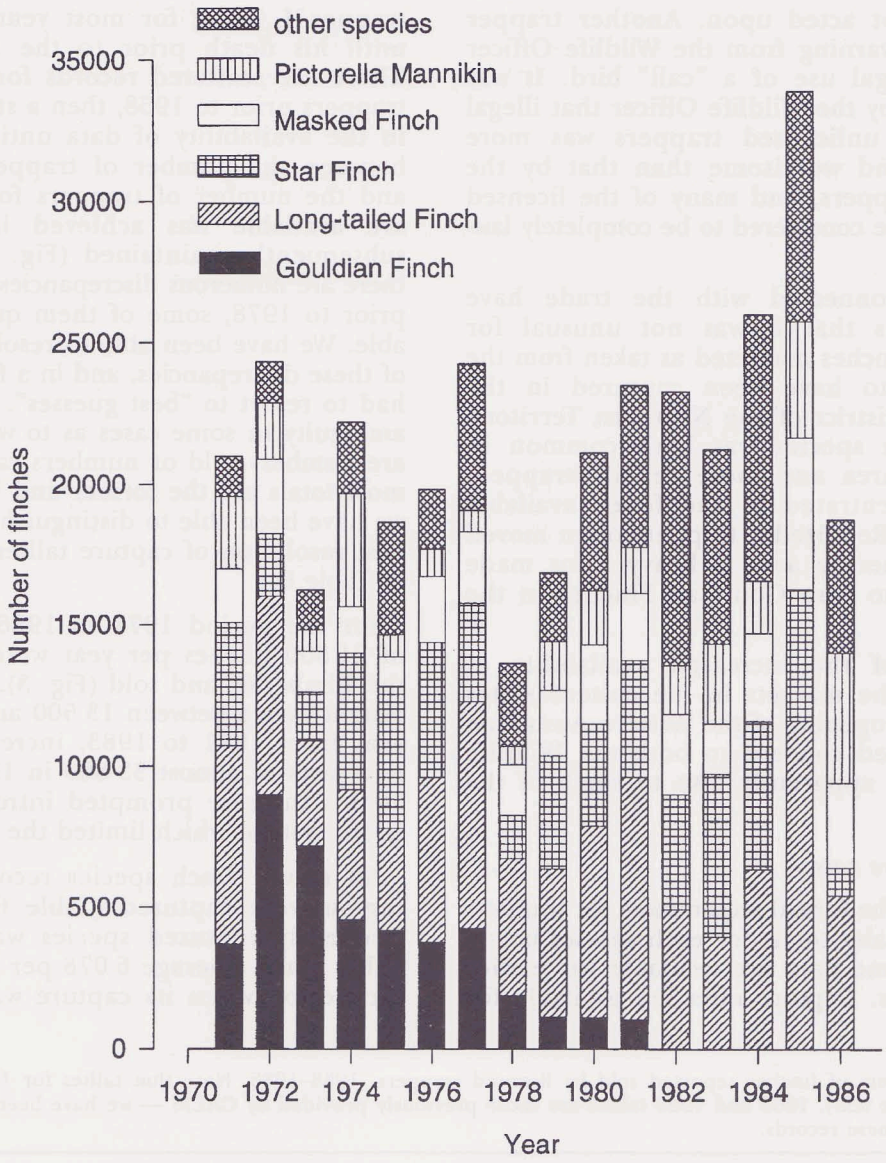

Figure 3. Capture rates of finches based on returns provided by licensed trappers, Kimberley, 1971–1986.

the Gouldian Finch was the second most frequent species, at an average of 3 813 per year, but over the entire period the number of Star Finches captured was greater (average 3 771 per year).

The Gouldian Finch was always a valued species (Table 5). There was a marked decline in its capture rate after 1977, a phenomenon that contributed to fears about its status and led to its protection in 1982. Crimson Finches were extremely valuable but capture was difficult compared to many species because they do not form large flocks, and inhabit watercourses with an abundance of permanent water. Though also relatively valuable, few Painted Finches were captured because of their scattered and generally sparse distribution and concentration in habitats (rocky areas with spinifex) and areas (particularly the drier southern Kimberley) less-frequented by other finches and consequently by the trappers. Few Yellow-rumped Mannikins were captured, and from 1976 trapping of the species was prohibited due to its rarity. The capture rates of the Double-barred Finch and Chestnut-breasted Mannikin, neither of which was particularly valuable, increased markedly through the period, the capture rate of the former but not the latter being positively correlated with an increase in relative price (unpubl. data). Few Zebra Finches were sold because their abundance and productivity in captivity rendered wild-caught birds close to valueless.

Masked, Long-tailed and Star Finches were caught much more reliably than other species.

Amongst species caught throughout the period, variability between years was particularly great for the Pictorella Mannikin and the Gouldian Finch. The pattern of between-year variability was similar for the period 1971 to 1981 (all trappers combined) as it was for trapper J. Long from 1948 to 1972 (from Table 7, species ranked by their c.v.'s, $r_s = 0.98$, $n = 9$, $P_{(one\text{-}tailed)} << 0.001$), as was the rank order of species according to frequency of capture ($r_s = 0.95$, $n = 9$, $P_{(one\text{-}tailed)} < 0.001$).

Table 7. Between-year variability in capture rates of finch species. Data are coefficients of variation for the nine species for which trapping was permitted throughout both periods.

Species	1971–1981, all trappers	1948–1972, J. Long
Masked Finch	.256	.398
Long-tailed Finch	.270	.419
Star Finch	.330	.435
Double-barred Finch	.475	.591
Pictorella Mannikin	.604	.744
Gouldian Finch	.638	.616
Crimson Finch	.713	1.198
Chestnut-breasted Mannikin	.942	1.288
Painted Finch	1.829	2.321

The increase in the numbers of finches captured in the mid-1980s occurred even though only seven trappers were operating, fewer than at any stage since at least 1970. There was great variability between years in the total captures and proportionate capture of species for individual trappers, as illustrated for trapper J. Long (Fig. 4). Most trappers caught between 1 000 and 3 000 finches per trapping season (Fig. 5). A few, known for their greater effort and skill, consistently captured more than 3 000 per year, including J. Long until ill-health restricted his efforts in the mid-1970s.

Tidemann (1993) reported captures of about 20 birds per firing of a spring-loaded net and up to 200 birds captured in a morning. Wildlife Officers reported as exceptional the capture of 500 Star Finches in 1 hour and more than 400 Pictorella Mannikins in one day. These data lead us to question Slater's (1980) report from 1957 of an aviary containing 8 000 Gouldian Finches captured by the one trapper (in the one season?). Even less likely is the suggestion that a single trapper caught "20 000 dozen"

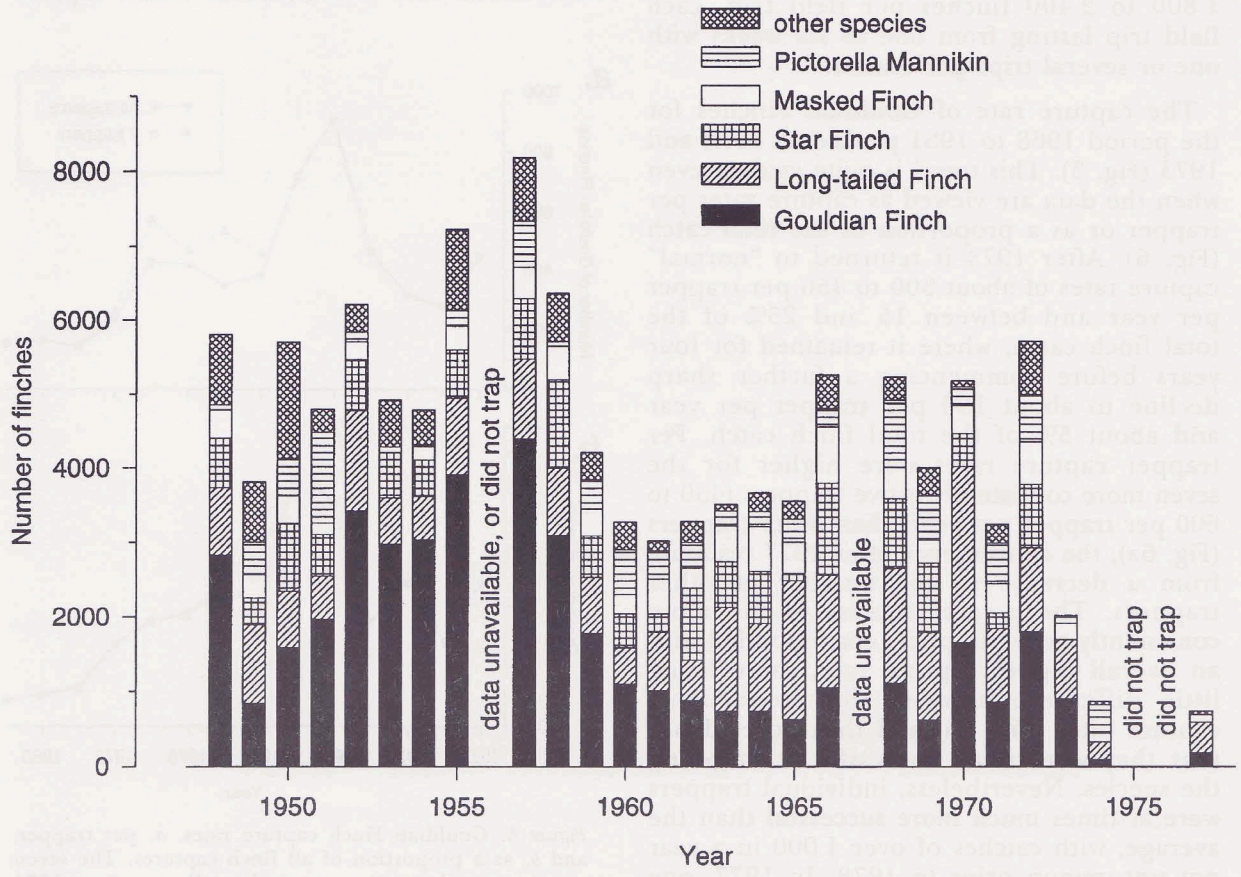

Figure 4. Capture rates of finches by trapper J. Long, Kimberley, 1948 to 1977.

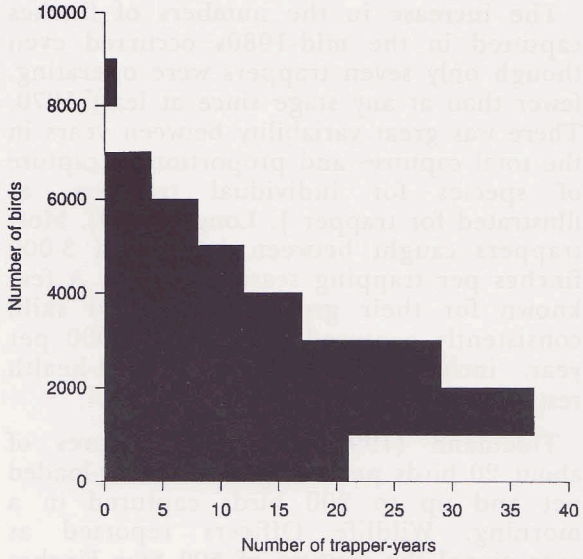

Figure 5. Frequency distribution of annual tallies of finches caught by each trapper. Data are for 1971 to 1986, excluding trapper J. Long.

birds in the Kimberley in three months (presumably in the late 1940s, Sharland 1949). The tallies for the more productive trappers documented in the CALM data are similar to those of Perez (1955), who, while trapping in the Northern Territory, reported trapping 1 800 to 2 400 finches per field trip, each field trip lasting from one to six weeks with one or several trips per season.

The capture rate of Gouldian Finches for the period 1968 to 1981 peaked in 1972 and 1973 (Fig. 3). This trend is quite evident even when the data are viewed as capture rates per trapper or as a proportion of the total catch (Fig. 6). After 1973 it returned to "normal" capture rates of about 300 to 450 per trapper per year and between 15 and 25% of the total finch catch, where it remained for four years before commencing a further sharp decline to about 150 per trapper per year and about 5% of the total finch catch. Per trapper capture rates were higher for the seven more consistently active trappers (450 to 600 per trapper per year) than other trappers (Fig. 6a), the convergence after 1977 resulting from a decrease in the number of other trappers. The greater success of the more consistently active trappers corresponded with an overall higher capture rate, there being little difference between the proportional capture rates (Fig. 6b) and thus no evidence that they were more successful at targeting the species. Nevertheless, individual trappers were at times much more successful than the average, with catches of over 1 000 in a year not uncommon prior to 1978. In 1977, one trapper reported catching 2 134 Gouldian Finches. The maximum number of Gouldian Finches caught by a trapper in a season was 4 396, by J. Long in 1957, although it is not known how many assistants Long had working for him at the time.

Regression analyses of Gouldian Finch capture rates

For the *jlong* data set, both the total catch and proportional catch of Gouldian Finches declined with time (Table 8). However, in analyses containing all variables including year, the only significant variable was Period, and the variable Period explained a greater portion of the variance than did Year. The dichotomy of trapping patterns before and after 1960 is clearly evident in the data (Fig. 4). We therefore analysed the data for these two periods separately.

For both *jlong* periods separately and both the total and proportional catch, there was no significant regression with Year alone as the independent variable (P all > 0.15). Regressions against all variables, and all variables except year produced complex and inconsistent results that are difficult to interpret, examples from the period prior to 1960 being presented in Table 8. Rainfall Previous Wet was prominently and negatively correlated with the Gouldian Finch capture

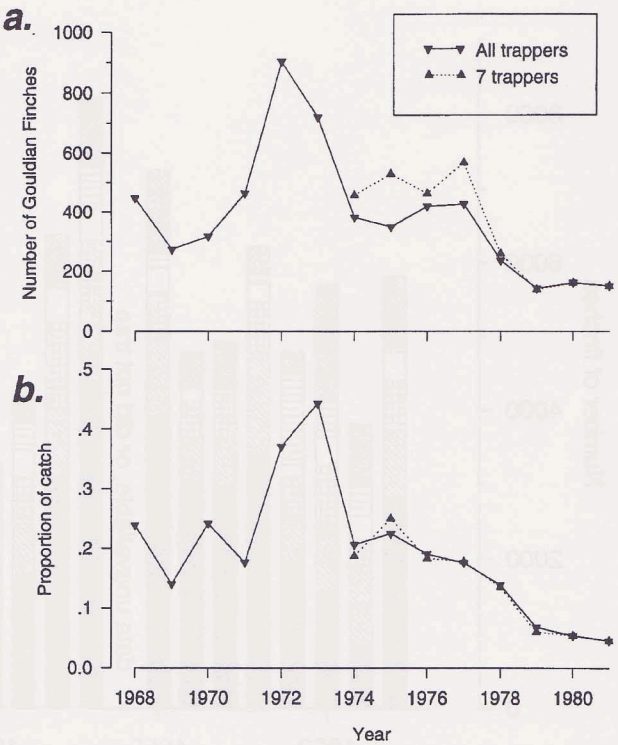

Figure 6. Gouldian Finch capture rates. *a.* per trapper, and *b.* as a proportion of all finch captures. The seven trappers are those who operated in all years from 1974 to 1981.

Table 8. Selected results of regression analyses of Gouldian Finch capture rates. IV = independent variable, Coeff. = partial coefficient, $P_{(var)}$ = probability associated with the variable, R = regression coefficient, F = F value for the regression, $P_{(reg)}$ = probability associated with the regression, DV = dependent variable. In the IV column, R = rainfall.

Analysis	IV	Coeff.	$P_{(var)}$	R	F	$P_{(reg)}$
jlong dataset						
DV = total IV = year	Year	−0.928	0.009	0.53	8.3	0.009
DV = proportion IV = year	Year	−0.012	0.003	0.59	10.9	0.003
DV = total IVs all	Period	−19.565	<0.001	0.77	27.8	<0.001
DV = proportion IVs all	Period	−0.233	<0.001	0.75	27.0	<0.001
jlong dataset prior to 1960						
DV = total IVs all	R Previous Wet R During Dry (R Late Wet)^2 R Late Wet	−0.064 0.290 0.000 −0.195	<0.001 0.001 0.007 0.017	0.96	16.3	0.002
DV = proportion IVs all	R Previous Wet (R Late Wet)^2	−0.001 0.000	0.001 0.030	0.76	5.3	0.034
alltrappers dataset						
DV = price(GF) IV = year	no significant result			0.11	0.1	0.716
DV = per trapper IVs = year, price	Year	−0.699	0.037	0.56	5.5	0.037
DV = proportion IVs = year, price	Year	−0.022	0.016	0.63	7.9	0.016
DV = per trapper IVs all	Year Variability Onset Wet	−0.870 −2.042	0.008 0.049	0.73	6.1	0.017
DV = per trapper IVs all weather	R Late Wet Onset of Previous Wet	0.064 −0.054	0.010 0.042	0.68	4.8	0.032
DV = proportion IVs all weather	R Late Wet Onset of Previous Wet	0.002 −0.002	0.006 0.033	0.71	5.6	0.021

rate for the earlier *jlong* period, but appeared only once, as a secondary variable with a positive relationship to capture rate for the later *jlong* period. The variable Variability in Onset of Wet was prominent in results for the later *jlong* period only, being negatively correlated with Gouldian Finch capture rates (full results not presented).

There was no consistent trend in the value of Gouldian Finches and Year (Table 8). Not surprisingly, the capture rate of Gouldian Finches (*alltrappers* analyses) was negatively correlated with Year, a trend evident for both per trapper and proportional capture rates; Price was not a significant correlate (Table 8). When all independent variables were included in the model, Year was the major correlate for the per trapper capture rate (Table 8), and the sole correlate for the proportional capture rate (see regression for Proportion *vs* Year and Price. However, when Year (and Price) were removed from the analysis, Rainfall Late Wet and Onset of the Previous Wet were the significant correlates (Table 8).

The variables Rainfall Late Wet and Rainfall Late Wet Squared appear in tandem only in the *jlong* dataset prior to 1960 (Table 8), and for both the total catch and proportional catch the relationship is negatively quadratic; i.e., it is lowest at mid-levels of rainfall, quite contrary to Mitchell's hypothesis. When regressed against both per trapper and proportional capture rates for the *alltrappers* dataset (the dataset, with some modification, on which Mitchell's hypothesis was founded) in the absence of all other variables, no significant model resulted (P both > 0.15).

DISCUSSION

Finch trapping as "sustainable conservation"?

The commercial trapping of finches in the Kimberley began and concluded long before the term "sustainable conservation" was coined by Armstrong and Abbott (1995) to describe a range of conservation strategies including sustainable utilization, and the adoption of such strategies in Western Australia.

Sustainable conservation seeks to enhance or achieve conservation goals by placing an economic value on biological resources in such a way that conservation effort is financially supported and that public conservation reserves are embedded in a landscape that is supportive of conservation goals rather than antipathetic to them. Although it may be wrong to judge the past by present perceptions and standards, it is certainly appropriate to learn from past experiences, and this is what we attempt to do here.

The Kimberley finch trapping industry placed an economic value on finches, provided some part-time employment and a small amount of revenue for the Western Australian government. In 1985, the year that capture rates peaked, the gross return to trappers was approximately $140,000 (based on data in Tables 5 and 6), an average of $20,000 per trapper. Our estimate of the revenue raised by the government from licence fees and royalties ranges from $790 in 1974 to $3,190 in 1984 (Table 4), but these calculations do not include royalties paid by dealers (cf. trappers) who sold finches interstate. However, amounts raised in other years, and whether this was sufficient to cover the costs of issuing and supervising licences is unknown to us.

However, the industry had no explicit conservation goals. It appears to have originated and operated in the "pioneering" milieu (*sensu* Shea *et al.* 1997) in which the "world" was perceived as a largely unoccupied wilderness with unlimited resources. That finch trapping continued to be permitted in the Kimberley long after it was prohibited elsewhere in Western Australia and throughout the remainder of Australia quite possibly reflects the ongoing status of the Kimberley region as comparatively undeveloped, and perhaps also that finches were regarded as pests in the intensive agriculture areas near Kununurra that developed in the early 1970s following the damming of the Ord River. The prohibition of trapping at the end of the 1986 season reflected the growing tensions between the pioneer ethos and the more conservation-oriented ethos of the majority of Western Australians. It is doubtful that it was a response to any real threat posed by the industry to the conservation status of finches (see below), although a sharp increase in capture rates from 1983 to 1985 was of some official concern. The conservation ethos is associated, perhaps inevitably, with an era of closer settlement, an era and pattern of settlement with which most Western Australians were associated by 1986 (Shea *et al.* 1997). Indeed, the classic tension between conservation and development may be understood as a tension between world views resultant or at least related to the differential intensity of settlement and economic development within political regions.

Conservation goals may, however, be implicit, or conservation achievements accidental. The trappers were demonstrably committed in the long term to their industry, and thus doubtless to the maintenance of their resources. This was exhibited in various unpublished documents in which concern was expressed by trappers about the degradation of waterholes by cattle, the loss of prime finch habitat under the spreading waters of Lake Argyle in the early 1970s, the appearance of illegally trapped birds on the eastern Australian markets and the declining capture rates of the Gouldian Finch.

Did commercial finch trapping place an economic value on habitat, thus promoting habitat retention? Evidently not. The finch trappers were not, for the most part, graziers or major landholders. We are aware of no evidence that the industry provided any benefit, financial or otherwise, for the people who could conserve habitat, nor even any method, apart from perhaps the rather intangible consequences of reducing grazing pressure, by which landholders could have promoted finch habitat conservation.

Did commercial finch trapping prevent illegal trapping? Certainly not completely, though there can be little doubt that the trade reduced the incidence of illegal trapping by reducing the incentive for it and providing a rationale and some financial support for the presence of a wildlife enforcement officer in the region. This process may well have benefited the Gouldian Finch. The regulated, legal trade in the species was discontinued when trapping returns suggested the species may have problems (but see below) even though trapping of other species continued; this combination of circumstances probably limited illegal trapping of the species after 1981, providing the necessary window of time in which aviculturists mastered the difficult art of breeding the species (Evans and Fidler 1986; Sammut and Marshall 1992; Kingston 1994). The incentive to illegally trap wild Gouldian Finches is now small because the species is bred prolifically in captivity and prices are fairly low (R. Ackroyd, pers. comm.).

The only population monitoring associated with the finch trade was that provided by the returns of the trappers themselves. This was "effective" only from 1974, when reasonable accounting of capture rates was fully

implemented. Its implementation permitted the detection of the sharp decline in the capture rates of the Gouldian Finch after 1977 and led directly to the prohibition on trapping of the species after 1981. It could be argued that the four years between the onset of decline and the implementation of protection was too long. It could equally be argued that the data were inadequate to confirm the trend any sooner. Had reliable records been available from an earlier time, there is little doubt that the reality of the trend could have been ascertained several years sooner than it was. With the benefit of hindsight, the lack of adequate monitoring (even self-monitoring) of capture rates throughout most of the life of the industry was a serious shortcoming of the supervision of the industry.

Was the industry sustainable? With the possible exception of the Gouldian Finch it would appear so, the industry having survived for at least forty years, with no decline in the total capture rate since at least 1971. Whether it would have remained so in the face of the ongoing pastoral and agricultural development of the Kimberley region, and of increasing numbers of aviculturists, is unclear. Whether the industry may have contributed to the decline of the Gouldian Finch is considered subsequently.

Aviculture and the paradox of sustainability

One of a number of strategies by which "sustainable conservation" may provide conservation benefits is that values placed on biological resources encourage landholders to maintain and manage habitat for those resources (Moran 1992; Bridgewater and Walton 1996). Habitat maintenance is a long-term problem and for this strategy to work, the biological resource must have a long-term value. The avicultural paradox is that the harvest of wild birds may permit the establishment of a self-maintaining captive population, thus undermining the long-term economic value of wild birds. On the other hand, if the harvest of wild birds does not contribute to the establishment of viable captive populations, the ethics of the harvest are likely to be questioned by many people. If the establishment of viable captive populations is a priority, then the ongoing harvest of wild birds may undermine the process by reducing market values (Shephard 1994).

Two examples, one recent and one proposed, illustrate the point. The limited harvest of the Naretha Bluebonnet *Northiella haematogaster narethae* from the wild was targeted so as to permit and promote establishment of a viable captive population (Shea *et al.* 1997). Subsequent success in captive breeding is argued to have undermined the illegal and destructive trapping of this parrot, as well as providing financial benefits for conservation. However, in so doing, it cannot be argued to have placed an economic value on the Bluebonnet's habitat.

A proposed harvest of the northern race of the Red-tailed Black-Cockatoo *Calyptorhynchus banksii macrorhynchus* in the Northern Territory (Parks and Wildlife Commission of the Northern Territory 1997; Vardon *et al.* 1997) is intended to provide conservation benefits through the issue of tradeable collection permits to landholders in return for agreements to protect habitat. The viability of such agreements depends on the ongoing nature of the trade. Should captive breeding prove successful, or the market collapse under the increased supply of cockatoos from the wild as suggested by Garnett (1997) and as has happened with Carnaby's Cockatoo *C. latirostris* (Mawson 1997), the conservation rationale for the programme will become questionable.

The Kimberley finch trade did not undermine its own market position; on the contrary, the capture rates of less-valued species such as the Chestnut-breasted Mannikin and Double-barred Finch increased in the final years of the trade. On the other hand, wild Zebra Finches were virtually valueless because of the ease with which they are bred in captivity. With the prohibition of the trade, numbers of the Pictorella Mannikin, Chestnut-breasted Mannikin, Crimson Finch and Masked Finch in captivity have crashed (Shephard 1994). Concern about the future of these species in captivity was evident amongst aviculturists even before the prohibition of trapping (O'Gorman 1981; Evans and Shephard 1984; Welford and Williams 1984), and the prohibition of trapping was seen positively by some aviculturists as a challenge to improve captive breeding techniques (Myers 1985; Shephard 1994).

The Commonwealth prohibition of the commercial export of native fauna in 1960 encouraged the development of captive breeding techniques for the Gouldian Finch overseas (Evans and Fidler 1986). A consequence of this success was that overseas prices stabilized at a similar level to those in Australia even though wild stock was still available in Australia. With the protection of Gouldian Finches in Western Australia at the end of 1981, prices more than trebled (Chamberlain 1987), but the species is now bred freely in Australia and is considered amongst the more common native finches in

captivity (Shephard 1994). The clear message here is that an ongoing supply of a species from the wild can be a disincentive to breed them in captivity, particularly if the species is difficult to breed. That the ability to breed birds in captivity may be related to the incentive to do so was recognized in a demand rather than supply context by Moyle (1997).

What then are the lessons to be learnt from the commercial trade in wild finches from the Kimberley region? From a sustainable conservation perspective, it is important that any harvest be undertaken with clear and achievable objectives, an understanding of the potential for conflict between objectives, and an understanding of the relationship between economics and sustainability as applicable to the case in hand. If the objective is to establish a viable captive population, then a carefully targeted harvest to provide birds to skilled specialist breeders, as was the case with the Naretha Bluebonnet, may be appropriate, while the comparatively *ad hoc* collection of wild birds for the general market place such as the Kimberley finch trade, is clearly inappropriate. If the objective is to undermine the illegal trade, either strategy may be appropriate (Moyle, in press). Long-term protection of habitat as an objective is dependent on the maintenance of market values; but the maintenance of market values is uncertain and is in direct conflict with the objective of establishing a viable captive population. Furthermore, there are strong economic forces which tend to promote destructive exploitation of biological resources at the expense of future use (Caughley and Gunn 1996), and so long-term maintenance of market values is only likely within a strong regulatory environment.

These issues should be kept in mind should proposals ever be floated to again permit the harvest of wild native Australian finches, some of which (e.g., Chestnut-breasted Mannikin, Masked Finch) are common in the wild but difficult to breed in captivity.

Finch capture rates, 1968 to 1986

Despite a decline of over 50% in the number of trappers from 14 in 1973 to six in 1986, the number of finches captured did not decline. On the contrary, peak total captures occurred in 1984 and 1985 when just seven trappers were operating, declining the following year with the imposition of quotas (and a further reduction in the number of trappers). There is a number of likely causes of this phenomenon. The trappers that operated throughout the period were more committed, on average, than those that dropped out, and their net experience and skill increased with time as no new trappers were licensed. It is possible that the prohibition of trapping of the Gouldian Finch, a valuable species requiring special skills to capture in numbers, at the end of the 1981 season, promoted a less specialized approach to trapping, and the available data (Fig. 3) suggest an increase in the capture rate of "other" species, notably the low-priced Double-barred Finch and Chestnut-breasted Mannikin, along with the more highly-valued Crimson Finch. Improved access and equipment is also likely to have contributed to the maintenance of capture rates. In 1984 and 1985, it was the perception of the Wyndham-based Wildlife Officer that the increase in capture rates was due to a sense of urgency amongst the trappers, who were apparently aware that the tide of political sentiment was running against their trade. One factor that does not appear to have contributed is the general increase in the value of the finches — prices paid to the trappers generally rose at or at less than the inflation rate (unpubl. data).

Trappers differed considerably in the composition of their catches, reflecting different trapping areas and doubtless also different priorities and skill levels. There was also considerable between-year variability in the proportionate capture rates of each species (e.g., Fig. 3). However, the marked similarity of the relative species composition of the total catch and of the relative between-year variability of the species for a single trapper from 1948 to 1972 and all trappers from 1971 and 1981 suggests an underlying consistency and pattern that should facilitate numerical analyses.

Evidence of decline of the Gouldian Finch?

The data we have utilized for the analysis of Gouldian Finch capture rates are somewhat more complete and accurate than that previously published (Evans and Fidler 1986; Tidemann 1987; Anon. 1987; Shephard 1994), especially for the years 1970, 1972 and 1973. In previous reports, there has been no explicit statement or evident awareness that the data set prior to 1972 is substantially incomplete. Consideration of capture rates as either rates per trapper or proportional capture rates adjusts for this incompleteness and demonstrates that annual capture rates for 1968 to 1971 were quite similar to those for 1974 to 1977. This consideration eliminates the anomaly of low capture rates prior to 1972, thus also eliminating a major reservation about the strength of the evidence of decline in Gouldian Finch populations.

The capture rates for 1972 and 1973 were exceptional, but the reason for this is unclear. They do immediately follow the flooding of Lake Argyle, and there is no doubt that that event was a major perturbation in the ecology of the Ord River valley. Historically, the Gouldian Finch was quite common throughout the valley from Wyndham upstream to above the Lake (North 1898; Kilgour 1904; Hartert 1905; Mathews 1909, 1910), and it is likely that the flooding destroyed a substantial area of suitable habitat. The high capture rates are unlikely to be attributable to any attraction of the birds to the Lake both because the trappers required small, not large, waterbodies at which to operate, and because it is our experience that the Gouldian Finch also prefers small waterbodies. One possibility is that the flooding displaced many Gouldian Finches, rendering them more trappable until the population adjusted to its altered circumstances.

The other major potential problem with any interpretation of the data as evidence of a decline in Gouldian Finch populations is the (previous) lack of consideration of other factors that might have contributed to capture rates. Feasibly, capture rates could reflect or correspond with climatic or human variables in such a way that is either quite independent of finch population levels, or which reflect population levels responding to natural environmental variability. This was the hypothesis proposed by I. Mitchell (pers. comm.).

The only consistent correlates with Gouldian Finch capture rates that we could identify were that there appeared to be a major change in emphasis in the absolute and proportional capture rates of trapper J. Long in about 1960, and a negative correlation between year and both rates per trapper and proportional capture rates for the period 1968 to 1981. We were unable to identify any consistent rainfall correlates, and were unable to confirm the late wet season rainfall hypothesis of I. Mitchell.

The change in emphasis by J. Long corresponds almost exactly with the Commonwealth's prohibition of the export of native finches. It is quite possible that this led to a major shift in the market structure, a shift that could have particularly influenced J. Long who, as well as being a licensed trapper, was a Perth-based dealer who certainly exported finches at least interstate. However, confirmatory evidence is lacking, and other explanations, including a decline in the abundance of Gouldian Finches, are certainly possible.

The correlation between year and the capture rates of the Gouldian Finch between 1968 and 1981 could simply be a measure of its decline; it could, however, be the product of other progressive changes that occurred independent of Gouldian Finch populations, including a shortening of the trapping season, a decrease in the number of trappers, and improved access. Presumably, improved access would have increased, not decreased capture rates. Our analysis has shown that the decrease in the number of trappers does not explain the decline. A decrease in the length of the trapping season could feasibly have made Gouldian Finches a little harder to capture as trappers tended to capture more of them later in the season, and the trapping season was reduced by earlier finishing dates rather than later commencement dates. However, in practice trappers were rarely able to operate effectively after the middle of November because of the onset of the wet season. The timing of the decline in Gouldian Finch capture rates does not correspond with the shortening of the season, and the trappers, whose reports indicate that they were very aware of the lower Gouldian Finch capture rates, apparently did not suggest that a shortening of the season was responsible for the lower catch rates.

Our inability to demonstrate any rainfall correlates is disappointing, as it is clear from trapper and Wildlife Officer comments that rainfall did affect where, how and when the trappers operated. There are many possible explanations for our failure, including inaccuracies in the capture rate data, the inapplicability of rainfall data from a single weather station to all the areas in which the trappers operated, selection of inappropriate rainfall characters and the undoubted complexity of impacts of rainfall and other variables on capture rates.

We conclude that the evidence provided by the Kimberley finch trappers is consistent with a decline in the Gouldian Finch, and that a decline appears to be the most feasible explanation, though certainly not the only explanation, for the data.

Did the industry cause a decline in the Gouldian Finch by overtrapping? The data available to us do not really address this question. Certainly, the decline followed fairly soon, though not immediately after, a particularly intense period of trapping of the species (1972 and 1973). However, there is no evidence or even suggestion that in general, trapping of Gouldian Finches was more intense in the mid-1970s than it had been for many years prior, suggesting that at the worst,

trapping exacerbated a decline triggered by other factors. Evans and Bougher (1987) found no evidence of post-protection recovery in the numbers of Gouldian Finches drinking at waterholes in 1983 and 1985. The Gouldian Finch has a high potential reproductive output (Lawson 1993) and juveniles continue to constitute a high proportion of birds seen at waterholes (e.g., Evans and Bougher 1987), so the population would appear able to respond quickly to the removal of any population-limiting factor. Furthermore, the decline of the Gouldian Finch is a national problem both in the sense that its decline is not restricted to the Kimberley and that the Gouldian Finch is not the only declining granivorous bird in the tropical savannas, and, if anything, both these problems are less intense in the Kimberley than in the tropical savannas further east (Blakers *et al.* 1984; Garnett 1993).

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